TRANSMISSION- TO REFLECTION-DOMINATED TRANSITION IN SEYFERT 2 GALAXIES: THE XMM-NEWTON VIEW*

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In this paper we present the current status of a XMM-Newton program to observe an optically-defined, complete and unbiased sample of Compton-thick Seyfert 2 galaxies. The main goal of this project is the measurement of the occurrence rate of transition between transmission- (*i.e.* Compton-thin), and reflection-dominated spectral states. These transitions potentially provide information on the distribution of the obscuring matter surrounding the nucleus, and on the duty-cycle of the AGN activity. With about 2/3 of the whole sample being observed, we detected 1 further transition out of 8 observed objects, confirming previous suggestions that these transitions occur on time-scales ~50–100 years.

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1. The unstable temper of Compton-thick Seyfert 2s

Our group is pursuing a XMM-Newton survey of an optically defined, complete sample of X-ray obscured nearby Seyfert galaxies, classified as Compton-thick according to observations prior to the launch of *Chandra* and XMM-Newton. The main goal of this project is to measure the occurrence rate of transitions between "transmission-" and "reflection-dominated" spectral states (Matt et al. 2003, and references therein). Traditional wisdom associates "reflection-dominated" states to AGN covered by a Compton-thick (*i.e.* $N_H \geq \sigma_t^{-1} \simeq 1.5 \times 10^{24}$ cm^{-2}) absorber, which totally suppresses the AGN emission below 10 keV.

The discovery of "transmission-" to "reflection-dominated" state transitions (simply *transitions* hereafter: Guainazzi et al. 2002; Guainazzi 2002) fundamentally challenges this traditional wisdom, as well as - in a broader astrophysical context - a "static interpretation" of Seyfert Unification Models. In at least two out of the five known cases (Guainazzi 2002, Gilli et al. 2000), these transitions are best explained with variations of the AGN intrinsic power by at least one order of magnitude on timescales $\simeq$years, as in the Narrow Line Seyfert 1 Galaxy NGC 4051 (Uttley et al. 1999). At the same time, these results are consistent with the extension of the standard Unification Models proposed by Matt (2000), whereby the nuclear, pc-scale torus is responsible for the Compton-thick absorption only, whereas the Compton-thin matter is located at much larger distances, possibly associated to the host galaxy rather then to the nuclear environment.

In this paper we present preliminary results of this study, with 8 out of the foreseen 12 targets being already observed.

2. Th XMM-Newton results

These transitions are not ubiquitous on the time scale roughly defined by the average interval between the ASCA/BeppoSAX, and the XMM-Newton/*Chandra* observations (a few years). The Circinus Galaxy and NGC 1068, the closest and best studied Compton-thick AGN known, exhibit a consistently reflection-dominated spectrum across their whole recorded X-ray history (Fig.1), with very little spectral changes.

In Fig.2 we show a comparison between the ASCA/BeppoSAX and the XMM-Newton/*Chandra* measurements of two of the observables, which identify a transition: a) a change in the Equivalent Width (EW) of the K_α fluorescent iron line, from (less then) $\simeq$100 to several hundreds/thousand eV; b) hard (*e.g.* 2–10 keV) X-ray flux changes by a factor

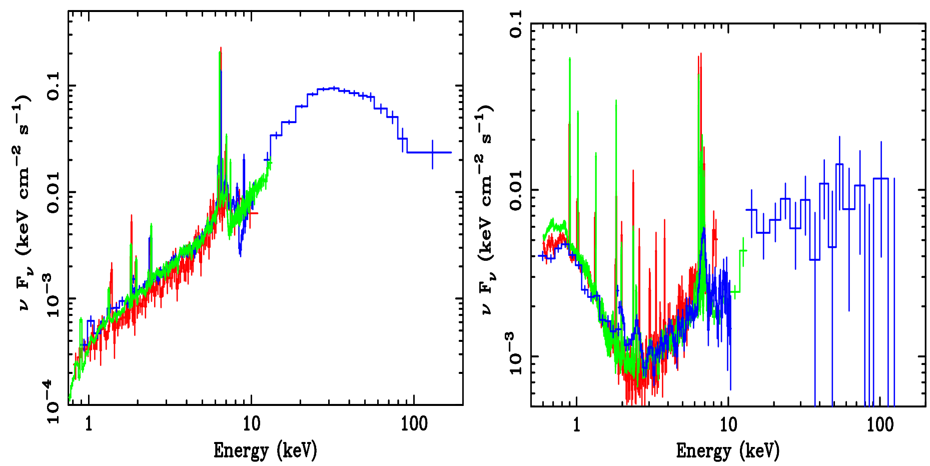

Figure 1. X-ray Spectral Energy Distributions of the Circinus Galaxy (*left*) and NGC 1068 (*right*) as derived from their ASCA, BeppoSAX and XMM-Newton observations

$\gtrsim$3–5; The same observables are shown for UGC 4203 as well, the prototyp-

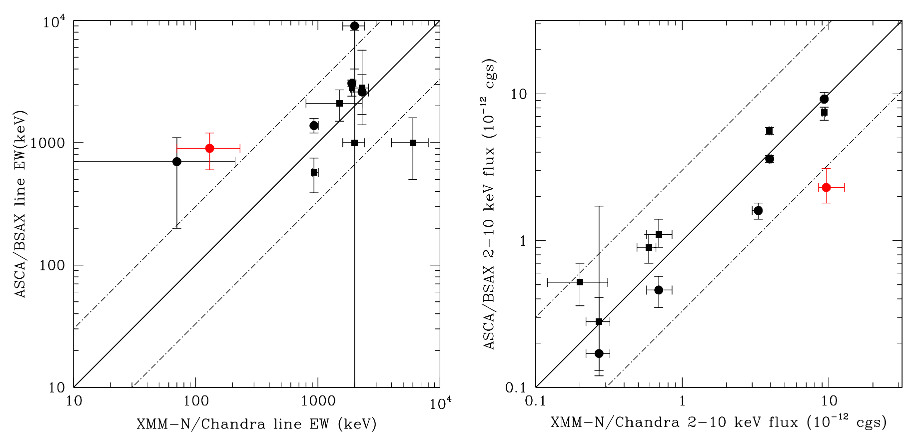

Figure 2. Comparison between measurements of the K_α fluorescent iron line EW (*left*) and the hard X-ray flux (*right*) between measurements done by ASCA/BeppoSAX (y-axis) and XMM-Newton/*Chandra* (x-axis). Objects from the XMM-Newton Compton-thick sample are indicated by *filled dots*, UGC 4203 (the prototypical "Phoenix Galaxy" with an *empty square*. The *dashed-dotted* lines indicate a factor of ± 3 variation from the equality (*solid*) line.

ical "Phoenix Galaxy" (Guainazzi et al. 2002). Out of 8 objects observed by XMM-Newton so far, 1 (NGC 4939) exhibits a $\gtrsim$ factor of 10 change in the K_α iron line EW, together with a moderate variation of the hard X-ray flux. This confirms previous results, suggesting that these transitions are detected in $\simeq$10% of nearby Seyfert 2 galaxies, when ASCA/BeppoSAX and XMM-Newton/*Chandra* observations are compared. Monte-Carlo simulations of Compton spectra produced by slabs with different column densities indicate that in NGC 4939 the absorber in the transmission-dominated and the reflector in the reflection-dominated state may have the same column density (Matt et al. 2003; cf. Fig. 3).

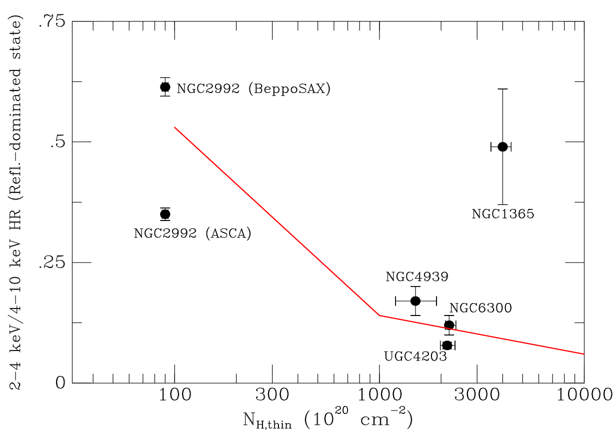

Figure 3. Comparison between the absorber column density measured during transmission-dominated states and the hard X-ray hardness ratio measured during reflection-dominated states for all the objects showing a transition. The *solid line* indicates the expected relation according to Matt et al. (2003). Objects *above* the line have never been reflection-dominated, despite their formal classification. For objects *below* the line the absorber and the reflector cannot have the same column density, by contrast with a scenario whereby a compact and homogeneous torus covers the nucleus. To the latter group belongs NGC 6300 as well (Guainazzi 2002), on the basis of its $E \geq 10$ keV RXTE spectrum.

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